GEOCHEMICAL REPRESENTATION OF PRINCIPAL AND ORBITAL QUANTUM NUMBER

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SUMMARY

The periodic system of elements may be visualized as a cylinder cut open along the line of the alkalis and smoothed out in a plane. If in this table all the possible subshells of electrons are given sufficient space to begin with, then in the L and M shell the continuation of the alkalis (subshell p) is placed on the extreme right, subshell d which is filled in the shells further below is placed on centre-right and subshell f, preceding it in still further shells, on centre-left. The advantage of this new arrangement is that, similarly to the Werner arrangement, the chemically affine groups are almost undisturbed. From a geochemical point of view, the related elements are placed close together in well-defined domains and the lanthanids and actinids are fitted in where they belong, among the pegmatophile elements. The stepped arrangement, advantageous from the didactical viewpoint, emphasizes the importance of the new subshells entering and makes the periodic system easy to read and understand. A drawback of the proposed arrangement is its somewhat cumbersome width.

The most widespread form of the so-called long arrangement of Mendeleev's periodic table of elements is the one proposed by Werner. As is generally known, every line of that table corresponds to the filling up of a shell of electrons, to an increase by one of the principal quantum number. The role of the subshells, of the orbital angular momentum quantum number (to be called orbital quantum number hereunder) is not at all apparent in this arrangement. This was remedied to a considerable degree by Fersman and then by Z. Szabó and his co-workers who exchanged the right and left sides of the well-known form of the long periodic table. This makes the filling up of the subshells easy to follow, but the beginnings of the individual rows do not coincide any more with the changes of the principal quantum number, i. e. with the beginning of the filling up of new shells.

The joint representation of the roles of the principal and orbital quantum number in the building up of the periods is most striking if the long periodic table is arranged as shown in the table below. (Fig. 1.) The periodic system,

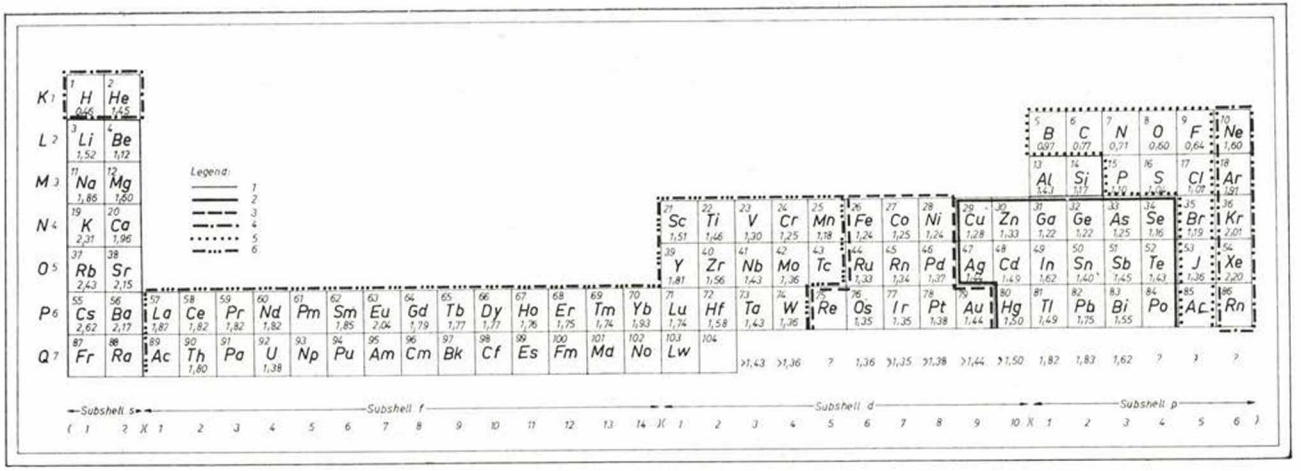

Fig. 1. The new form of the „long" periodic table

1. lithophile; *2.* chalcophile; *3.* siderophile; *4.* atmophile; *5.* sedimentophile; *6.* pegmatophile.

considered as a cylinder, is cut open parallel to its axis at the alkalis; in this way, the beginnings of the new shells are outlined in the first place. The column of alkalis and alkali earths, complemented with H and He, represent the filling up of the first subshell, s. If the space required for all possible subshells is left open to begin with, then in the L and M shells, the continuation of the filling up beyond the subshell s (i. e. of subshell p) is represented on the extreme right; subshell d, interposed between them in the following rows is placed on centre-right and subshell p, which precedes subshell d in the last rows, is placed on centre-left. Hence, the column of alkalis and alkali metals is succeeded by the lanthanids and actinids, corresponding to the filling up of subshell f; next come the transitional elements from the Sc group to the Fe-Pt group (subshell d) and finally the metalloids and inert gases (subshell p). Hence, this arrangement directly indicates the shells and subshells of electrons as they are arranged in the atom. The fillling up of the shells shows several jumps, e.g. in the Cu-Ag-Au group. The filling up of subshell d ceases at 8 electrons, and further filling up to ten d electrons is realized by the capture of an s electron from the next shell. This same jump is observed higher up in the table, at Pb, where both outer s electrons are incorporated into subshell 4d. For energetical reasons, none of the known elements carry nine d electrons: such an arrangement would be highly unstable. The jumps as phenomena of lesser importance have knowingly been omitted so as not to disturb the general image of the filling of the shells. There are further jumps at La and Ac: after the two outer s electrons, it is not the first f but the first s electron which is taken in, so that the filling of subshell f begins only at Ce and Th, respectively. However, periodic tables generally place the lanthanids and actinids in separate groups and treat La and Ac as the first terms of the lanthanid and actinid groups characterized by the filling up of subshell f.

The geochemical grouping of the elements is disrupted only in two instances: atmophile H and He are placed as s-electron elements above the alkalis which, although of a similar electron structure, are lithophile rather than atmophile. However, if the periodic table is visualized as it should be, i.e. as a cylindrical shell, it becomes apparent that H and He are next to the group of atmophile inert gases. The second case cannot be interpreted so simply: lithophile Al and Si cannot even in a cylindrical arrangement be brought next to the rest of lithophile elements. In this case, however, the electron structural arrangement of elements has been preferred to a rigorously consequential presentation of geochemical affinities.

On the basis of the phenomena of lanthanid and actinid contraction it is to be supposed that, after the filling up of the Q shell, a new shell (R) will appear in which a new subshell (to be called subshell e) is added to the earlier ones. This subshell will be situated in the third shell counted from the outside. It would hold a maximum of 18 electrons, as in the s-p-d-f sequence every subshell holds four electrons more than the preceding one. Since the filling up of subshell e takes place in a shell even deeper than the one containing subshell f, it would undoubtedly also entail a contraction, even more considerable than lanthanid or actinid contraction. After the filling up of subshell e, the subsequent elements would build up f, d and p subshells, as usual, and this would be the end of period R.

In principle, the succession of transurania might have been much longer than it is known today, but owing to the phenomenon of radioactive decay we know now only their end products, elements of lower atomic number. In the last few years, quite a number of transurania have been discovered and their number will presumably go on increasing, so that the above-outlined hypothesis might eventually be proved. The atomic radii of these hypothetical transurania may be extrapolated by determining the mean change per period of the atomic radius in the individual columns of the periodic table, and by adding this value to the radii of the last period. The table presents some of the data thus obtained. Both the atomic radii thus computed and the chemical nature of the unknown element to be derived from its position in the periodic table may be helpful in discovering new transurania.

An advantage of the arrangement proposed here is that, similarly to Werner's arrangement, the grouping of the chemically affine elements remains almost undisturbed. From a geochemical and geological viewpoint, that form is best which reflects most clearly the wellknown geochemical grouping of the elements. The arrangement proposed here gives a suitable delimitation – similarly to the arrangement of Szádeczky-Kardos (1955) – of the geochemical groups. Moreover, it fits in the lanthanid-actinid groups where they belong, in the group of pegmatophile elements.

The stepped arrangement of the elements, advantageous from the didactical viewpoint, emphasizes the gradual fillling up of the subshells and makes the periodic table clear and easy to understand.

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